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REPORTS

In this department every effort is made to publish timely announcements of future meetings, as well as reports of events and papers presented at past meetings. For this we rely on the organizers of meetings to send us announcements as early as possible, and on colleagues in each country to send us reports of local activities in the history of mathematics. Unnecessary duplication may be avoided by checking with the Editor or the nearest member of the International Commission listed on the back cover of *Historia Mathematica* before submitting reports to this department.

Seminar on Astronomy and Mathematics in Ancient and Medieval India: A Dialogue between Traditional Scholars and University-Trained Scientists

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A national seminar on Astronomy and Mathematics in Ancient and Medieval India: A Dialogue between Traditional Scholars and University-Trained Scientists was organized under the joint auspices of the Asiatic Society, Calcutta (founded in 1784), and the Indian Council for Philosophical Research, New Delhi, in collaboration with the Ramakrishna Mission Institute, Calcutta. It was held on the premises of the R. K. Mission Institute from May 19 to 21, 1987. This conference provided an opportunity for presentation of views on the three major aspects—history, philosophy, and sociology—of the two exact sciences in India during premodern times. The approximately 60 participants were mostly scientists, Indologists, historians of science, and *pandits* (traditional scholars).

In addition to the eight academic sessions, there was an inaugural session and a plenary session with which the meeting ended. The program of talks and presentation of papers may be briefly described as follows.

In his opening remarks at the inaugural session, Professor A. K. Saha, chairman of the organizing committee, said that scientists seem to be generally confident of their discoveries, laws, and beliefs, whereas philosophers question many aspects of these. He added that, in the past, dialogues have provided "a very important method for enlarging the boundaries of knowledge." He also pointed out that, in

ancient India, the method of dialogues became the only recognized method of transmission of knowledge from the teacher to the taught and from scholars to others.

In his inaugural speech, Swami Lokeswarananda of the R. K. Institute asked whether philosophy and science can be reconciled, since philosophy is considered to be a matter of subjective (personal) speculation while science is said to seek objective (impersonal) reality. He added that truth and knowledge together play the vital role of uniting and unifying.

Dr. Debriprasad Chattopadhyaya, who represented the Indian Council for Philosophical Research, pointed out how religious views sometimes interfered with scientific research, for instance, in the cases of Āryabhaṭa I (born A.D. 476) and Galileo. But now, he added, the "more science knows, the wider becomes the field of the unknown." Professor M. M. Chakrabarty, president of the Asiatic Society, mentioned that the Society was trying to bridge the gap between ancient and modern studies of science.

The following papers were presented in the academic sessions:

1. AMALENDU BAHDYOPADHYAY (Positional Astronomy Centre, Calcutta): "Astronomical Works of Samanata Chandresekhar"

Chandraśekhara (19th century) detected all four important irregularities of the lunar motion, namely the equations of center, evection, and variation, and the annual equation. His value for the solar year was 365.25875 days and his value for obliquity 23° 30′. His *Siddhānta Darpana* is being translated by Bandyopadhyay.

2. SADASIBA MISHRA (Sanskrit College Toll Department, Calcutta): "Bhāsvatī—Śatānanda's Contribution to Astronomy" [presented in Bengali]

The Sanskrit work *Bhāsvatī* (1099 A.D.) is very popular for computations of eclipses.

3. RAMATOSH SARKAR (Birla Planetarium, Calcutta): "Astronomical Shortcomings in Ancient Indian Treatises"

Instances of lapses (e.g., mere mention of the ratio 3:2 for durations of longest to shortest days) from the *Vedāṅga Jyotiṣa* and *Arthaśāstra* which Sarkar takes to belong to about 600 and 300 B.C., respectively.

4. RUMA BANDYOPADHYAY (Hooghly): "Possible Identity of Maya Referred to in *Sūrya Siddhānta*"

Maya is identified as a Mexican. (E. Burgess in his translation of the work had identified Maya with Ptolemy.)

5. A. K. CHAKRABARTI (M. R. College, Mahishadal): "Astronomical and Calendrical Evidence in Early Inscriptions"

He finds that astronomical data from the Kuṣāṇa inscriptions (200 B.C. to 200 A.D.) fit the Metonic cycle. He also examines data from earlier Ashokan edicts and from the inscriptions of later Gupta emperors whose court astronomers remodeled astronomical science in India.

6. KRISHNA DE (Sarojini Naidu College for Women, Calcutta) AND S. S. DE (University College of Science and Technology, Calcutta): "Some Astronomical Facts Recorded in the *Ṛgveda*" [read by KRISHNA DE]

They identify the twin gods Aśvins with the two stars in the constellation of Hyades in Taurus.

7. S. S. DE AND BAIDYANATH BASU (University College of Science and Technology, Calcutta): "Some Astronomical References in the Vedas and the Quran—A Comparison" [read by Baidyanath Basu]

They find striking similarities in some passages.

8. P. V. VARTAK (Pune): "Uranus, Neptune, and Pluto were known to the *Mahābhārata*"

He identifies these planets by the Sanskrit words *śveta, śyāma,* and *tīvra-graha,* respectively, and works out the date of the Mahābhārata war to be 16th October, 5562 B.C.

9. P. SREENIVASA ACHARYULU (Kaveli, Nellore): "The Four Stars Theory Developed from Ancient Indian Astronomical and Purāṇic Sources"

Conjectural theory identifying the stars in the *Bhāgavata Purāṇa* (XII, 11,22) named Aniruddha (= Sun), Pradyumna, Śāṅkarṣaṇa, and Vāsudeva.

10. JAGATPATI SARKAR (Hooghly): "Sun—The Astronomical Deity"

About the Vedic group of gods, called *Ādityas,* one of whom is *Sūrya,* the Sun.

11. V. I. GANDHI (Kaveli, Nellore): "V. L. Gandhi's Sky Atlas Based on Ancient Indian Astronomy"

Atlas prepared by redesignating certain constellations in the light of oriental mythology.

12. UMA DEY (Calcutta): "Observed and Calculated Positions of Planets in Ancient Indian Astronomy"

She points out how Indian astronomers compared the calculated positions of the heavenly bodies with the observed positions and noted occasional discrepancies.

13. K. V. SARMA: "Observational Astronomy in Kerla: An Insight"

According to Parameśvara (1360–1455), only those computed planetary positions that agree with observed positions should be deemed correct. His follower Nīlakaṇṭha (1444–1545) revised some of the parameters to achieve this agreement.

14. S. HARIHARAN (Bangalore): "Declination in Indian Astronomy and the Approach of Kerala Astronomers"

He points out that although Mādhava's (1340–1425) infinite series expansions of sine, cosine, and arctangent functions have frequently been published, his astronomical contributions are unknown. Mādhava gave an exact method for finding the declination of the moon and planets which are not situated on the ecliptic.

15. L. V. S. MANI (Madras): "Morning minus Evening equals Twice Equation of Time"

He discussed the correction in the above equation when change in the sun's declination is taken into account.

16. S. N. SEN (The Asiatic Society, Calcutta): "Approach of Traditional Scholars and Modern Scientists in the Evaluation of the Procedure by Half in Computing the *Śighra* and *Manda* Corrections for Planetary Positions"

The said corrections from the works of Āryabhaṭa I, Varāhamihira (6th century), and Bhāskara I (about 600 A.D.) were discussed, and the rationale for the procedure was explained on the basis of the eccentric–epicyclic geometrical model.

17. B. B. BHATTACHARYYA: "Some Conceptual Discrepancies or Obscurities Regarding the Formulae of Indian Mathematics as Adopted in European Mathematics and Astronomy"

Coefficients of various powers of x in the expansion of $(1 + x)^n$ are found in ancient Indian works on prosody as combination coefficients. The differential as well as the integral calculus can be regarded as an extension of *śreḍhī-gaṇita* (series mathematics).

18. NAVJYOTI SINGH (National Institute of Science, Technology and Development Studies, New Delhi): "Mathematics of Unnamable Finite Numbers Developed by Jainas"

The Jainas grouped numbers into three classes, namely *saṁkhyata* (finite ordinals), *asaṁkhyāta* (unnamable numbers considered here), and *ananta* (transfinite). The *asaṁkhyāta* are finite but cannot be represented by finite ordinals.

19. PARMESHWAR JHA (B.S.S. College, Supaul): "Algebra and Algebraic Equations in Ancient India"

Outline of different aspects of algebra from the *Vedas* (third millennium B.C.) to the fifth century A.D. including the Jaina tradition.

20. M. B. PANT (Pune): "Bhāskarācārya's Vargaprakṛti and Its Use in Three Consecutive Numbers"

Discussion of the solution of the indeterminate equation $ax^2 + b = y^2$ (called *vargaprakṛti*) as given by Bhāskara II (about 1150 A.D.).

21. R. S. LAL (D.A.V. College, Siwan): "Swami Śrī Bhāratī Kṛsṇa Tīrthaji and His Novel Methods of Solving Simple Equations"

Exposition based on some *sūtras* (aphorisms) from the book *Vedic Mathematics* by Tīrthaji (1884–1960).

22. B. CHAKI AND S. CHAKI (Calcutta): "A Brief Outline of Ancient Indian Algebra" [read by B. Chaki]

Emphasis on Indian algebraic terminology.

23. N. K. CHAKRABORTY (Calcutta): "Algebra and Ancient Indian Mathematicians"

About the treatment of equations both ordinary and indeterminate.

24. M. C. CHAKI: "On an Attempt to Prove Euclid's Fifth Postulate"

Examination of the proof by Paul Limrick as published in the *Asiatick Researches*, Vol. 7 (1801).

25. R. C. GUPTA (B.I.T. Mesra, Ranchi): "Volume of a Sphere in Ancient India"

Various rules for approximating a sphere's volume from the works of Āryabhaṭa I, Bhāskara I, Śrīdhara (8th century), Mahāvīra (9th century), and Bhāskara II, with possible derivations.

26. A. P. SINGH (Howrah): "Trigonometry in Ancient India"

Methods of computation of the sine (as distinguished from the Greek chord) of various angles.

27. YUKIO OHASHI (University of Lucknow): "Varāhamihira's Orthographic Projection—An Interpretation of the Pañcasiddhāntikā XIV, 5–11"

He finds translations (of the *Pañcasiddhāntikā* XIV, 5–11) given by G. Thibaut and D. Pingree to be unsatisfactory and presents his own "simple" interpretations.

28. R. K. KOCHHAR (Indian Institute of Astrophysics, Bangalore): "Social and Intellectual Implications of the Ancient Astronomical Tradition in India"

The history of science is also the history of man's intellectual development. The Indian milieu in which knowledge was treated as revelation could nurture mathematics and metaphysics but not physical inquiry.

29. BANDANA CHAKRABORTI (Serampore): "Some Social Implications of Studies in Astronomy in Ancient India"

The author points out that the purpose of astronomy was to prescribe suitable times for performing *yajña* (sacrificial rite) and to facilitate agriculture by determining appropriate seasons.

30. M. DAMODHAR (Secundrabad): "Ancient Knowledge about the Velocity of Light"

Applying the later *Kaṭapayādi* System (a sort of *Gematria*) to some ancient Sanskrit phrases such as *Sūryaratham* ("sun's chariot"), Damodhar arrives at the figure 187,670 miles per second.

31. M. S. KHAN (Calcutta): "The Teaching of Mathematics and Astronomy in the Traditional Institutions of Medieval India"

Concerned with the Islamic system of education as followed in the *maktabs* and *madrasahs*. According to Khan, "higher mathematics including astronomy was taught as a compulsory subject in all institutions of higher learning run by the Hindus and Muslims throughout the Mughal period."

32. MIRA ROY (Calcutta): "Astronomy and Alchemy in India—A Correlated Study"

Discussion of the symbolic use of heavenly phenomena in alchemical practices and the correlation between metals, gems, and heavenly bodies.

The final session was devoted to a "Dialogue on Issues in Mathematics and Astronomy." It was expected to be the most important part of the Seminar, since the main objective of the conference was to provide a platform for a dialogue on issues relating to the foundations and methodology of Indian astronomy and mathematics. More than a month before the start of the seminar, the following five questions were sent to each participant:

(i) What is the nature of mathematical knowledge? How does it differ from, say, knowledge in Āyurveda on one hand and from linguistics and astronomy on the other?

(ii) What is the nature of those objects of which knowledge is sought in the science of mathematics? Are they like other spatio-temporal objects whose knowledge is sought in the various sciences? If not, how are these objects encountered in experience to become objects of knowledge?

(iii) How is mathematical knowledge validated? Is this process of validation essentially different from that which obtains in the other *Śāstras* [traditional sciences]?

(iv) What is the relation between different branches of mathematics? Are these concerned with varieties of the same objects or with different objects? If the latter is the case, what is the point of grouping them under one discipline?

(v) Is astronomy the only science which has to use mathematics as a necessary instrument for its study? If so, what are the special characteristics of the object of astronomical knowledge which necessitate this?

These questions provided basic issues for discussion. Six keynote talks were delivered:

33. VIRENDRA SHEKHAWAT (Rajasthan University, Jaipur) spoke on the nature of mathematical objects according to the teachings of some Indian philosophical schools, although he admitted that little attention has been paid to the issue in classical Indian thought.

34. P. K. GHOSH made a few general remarks on the issues involved.

35. B. B. BHATTACHARYYA spoke mainly on issue (iii). He said that according to the Nyāya–Vaiśeṣika school, validation of any sort of knowledge depends entirely upon the validity of the instrumental cause of a perception regarding an object which fulfills the requisites of the perceiver.

36. M. D. SRINIVAS (University of Madras) spoke on the notion of *upapatti* ('proof,' 'derivation,' or 'demonstration') for validation of mathematical results in Indian tradition in contrast to the notion of proof in western mathematical tradition.

37. D. K. SINHA (Calcutta University) spoke on issue (iv). He said that the history of mathematics with its many facets is replete with examples of interconnections between logic and intuition. Each branch of mathematics depends, historically speaking, on a particular intuition that provides it with primitive notions and truths, which, in turn, must have acquired a formalized language exclusively of its own.

38. NAVJYOTI SINGH spoke on various methodological and foundational aspects of mathematics in ancient India. He cited his earlier work related to the philosophical side of the Indian mathematical tradition.

At the end in the Plenary Session, the following resolution was adopted:

> Serious research work should be initiated on the methodology and foundations of mathematical sciences in India (1) with a view to placing the Indian tradition in mathematical sciences in the proper perspective and (2) with a view to fostering creative use of insights from the Indian tradition in mathematical sciences in current research. In order to undertake such research it is very essential that the vast source material (mostly in manuscript-form) on Indian mathematical sciences should be made accessible to our scholars in microfilm or preferably in published form, on a priority basis.

Summaries of most of the papers and talks were made available in the form of a printed booklet "Programme and Abstracts," which also contained summaries of a large number of papers whose authors were not present. The booklet also gives an alphabetic list of participants with their full addresses.

Mathematische Probleme im Mittelalter—Der lateinische und arabische Sprachbereich
Wolfenbüttel, June 18–22, 1990

The workshop on "Mathematical Problems of the Middle Ages—The Latin and Arabic Language Region" was organized by Menso Folkerts (Munich, FRG). It took place at the Herzog August Bibliothek Wolfenbüttel.

The following 16 lectures were delivered (in chronological order):